RoHS Compliant Multi-Rate CWDM SFP Transceiver for SONET OC-48/SDH STM-16 with DDM Function

FEATURES

- **Compliant with SFP Transceiver SFF-8472 MSA specification with internal calibration**
- **Multi-rate operation from 125 to 2670Mpbs**
- **Single + 3.3V Power Supply and TTL Logic Interface**
- **Uncooled DFB laser transmitter and APD receiver**
- **Eight CWDM wavelength available**
- **EEPROM with Serial ID Functionality**
- **Laser Class 1 Product which comply with the requirements of IEC 60825-1 and IEC 60825-2**
- **Duplex LC Connector interface**

Description

The LCP-2488 CWDM series are designed for coarse wavelength division multiplexing applications (CWDM) and hot pluggable SFP transceiver modules that data rates up to 2.67Gb/s. The LCP-2488 CWDM series are support OC-48/ STM-16 as well as 2x Fiber channel (2.125Gb/s), GbE (1.25Gb/s) and 1x Fiber channel (1.062Gb/s). The selectiveness of center wavelength has 1470, 1490, 1510, 1530, 1550, 1570, 1590, and 1610nm.

The LCP-2488 CWDM series are designed to be compliant with SFF-8472 SFP Multi-source Agreement (MSA) with digital diagnostic monitoring functions: Temperature, V_{CC}, TX optical power, TX laser bias current, and RX received optical power.

The post-amplifier of the LCP-2488 CWDM series also includes a Loss of Signal (LOS) circuit that provides a TTL logic-high output when the received optical level is below a preset LOS Assert threshold.

Applications

- ATM switches and routers
- SONET/SDH switch infrastructure
- xDSL applications
- Gigabit Ethernet
- Switch to Switch interface
- Switched backplane applications
- File server interface

Performance

- LCP-2488D4RxxR: 1470nm to 1610nm CWDM DFB laser transmitter and APD receiver, 28dB link budget

Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Storage Temperature	Ts	-40		85	ºC	
Supply Voltage	Vcc	0		5	V	

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Case Operating Temperature	Tc	-5		70	ºC	1
Supply Voltage	Vcc	3.135		3.465	V	
Data Rate		155		2666	Mbps	

Note 1: See order information

Electrical Characteristics

(V_{CC}=3.3V ± 5%)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Total Supply Current	Icct		220	380	mA	
Transmitter						
Transmitter Differential Input Voltage	Vdt	0.5		2.4	V	1
Transmitter Disable Input-High	V_{DISH}	2		V_{CC}+0.3	V	
Transmitter Disable Input-Low	V_{DISL}	Vee		0.8	V	
Transmitter Fault Pull up Resistor	R_{TX_FAULT}	4.7		10	kΩ	2
Transmitter Fault Output-High	V_{TXFH}	2		V_{CC}+0.3	V	
Transmitter Fault Output-Low	V_{TXFL}	Vee		0.8	V	
Receiver						
Receiver Differential Output Voltage	Vdr	0.35		2	V	3
Receiver LOS Load	R_{RXLOS}	4.7		10	kΩ	2
LOS Output Voltage-High	V_{LOSH}	2		V_{CC}+0.3	V	
LOS Output Voltage-Low	V_{LOSL}	Vee		0.8	V	

Notes:

1. Internally AC coupled and terminated to 100Ohm differential load.
2. Pull up to V_{CC} on host Board
3. Internally AC coupled, but requires a 100Ohm differential termination at or internal to Serializer/ Deserializer.

Optical Characteristics

Transmitter

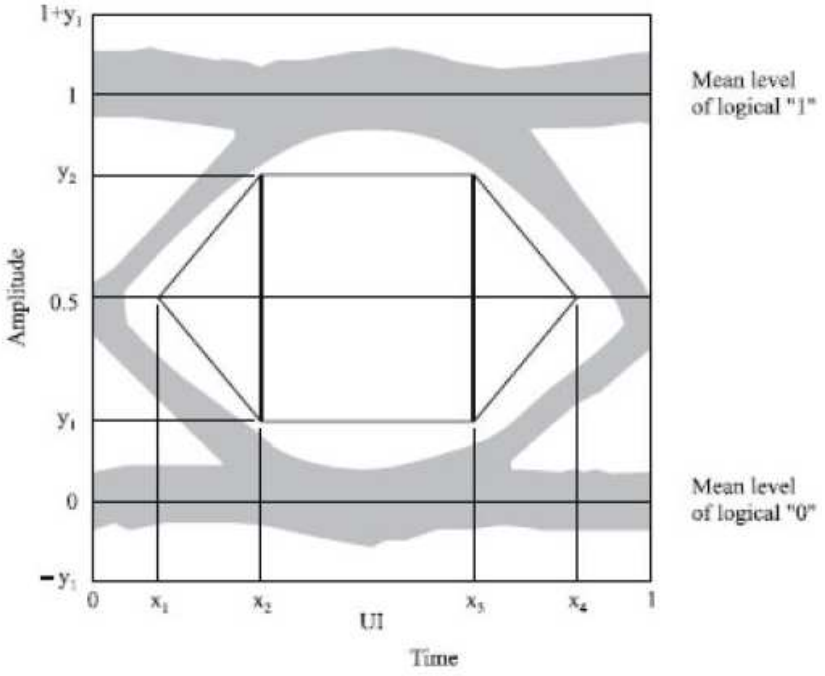
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Output Optical Power (Avg.)	P	0		+5	dBm	1
Optical Extinction Ratio	ER	8.2			dB	
Center Wavelength						
LCP-2488D4R47R		1464.5	1471	1477.5		
LCP-2488D4R49R		1484.5	1491	1497.5		
LCP-2488D4R51R		1504.5	1511	1517.5		
LCP-2488D4R53R	λ_C	1524.5	1531	1537.5	nm	
LCP-2488D4R55R		1544.5	1551	1557.5		
LCP-2488D4R57R		1564.5	1571	1577.5		
LCP-2488D4R59R		1584.5	1591	1597.5		
LCP-2488D4R61R		1604.5	1611	1617.5		
Spectral Width (-20dB)	σ			1	nm	
Side-mode Suppression Ratio	SMSR	30			dB	
Optical Rise/ Fall Time	t_r/t_f			150	psec	2
Relative Intensity Noise	RIN			-120	dB/Hz	
Jitter (peak to peak)	J_{PP}			0.1	UI	
Return Loss	RL	24			dB	
Dispersion Penalty @ 80 km				2.5	dB	3
Output Eye	Compliant with GR-253-CORE and ITU recommendation G.957					

Receiver

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Sensitivity (Avg.)	P_S			-28	dBm	4,5
Input Optical Wavelength	λ	1450		1620	nm	
LOS-Deasserted (Avg.)	P_A			-28	dBm	
LOS-Asserted (Avg.)	P_D	-45			dBm	
LOS-Hysteresis	P_A-P_D	0.5			dB	
Overload	P_0	-10			dBm	
Reflectance	r			-27	dB	

Notes:

1. Measured at 155Mbps, 166.7Mbps, 622Mbps, 2488Mbps, 2.67Gbps PRBS2^{23}-1, 50% duty cycle, and measured at 1250Mbps, PRBS2^{7}-1, 50% duty cycle.
2. These are unfiltered 20%~80% values.
3. SMF-28 fiber used. 80 km represents 1600ps/nm at 1610nm. Measured at 2.488 Gb/s with a PRBS 2^{23}-1 pattern at a BER<10^{-10}.
4. The range of input powers where BER<10^{-12} and valid from 155Mbps to 2.67Gbps..
5. Not including dispersion penalty (fiber dispersion value: -500~+1600ps/nm)



	STM-1	STM-4
x1/x4	0.15/0.85	0.25/0.75
X2/x3	0.35/0.65	0.20/0.60
y1/y2	0.20/0.80	0.20/0.80

	STM-16
x3-x4	0.2
y1/y2	0.25/0.75

Figure 1.Mask of the eye diagram for the optical transmit signal (ITU-T G957)

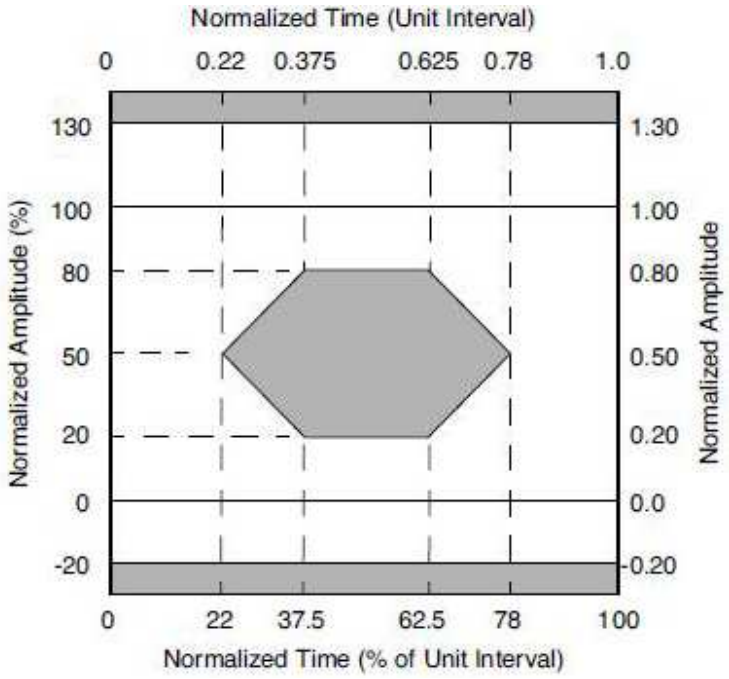
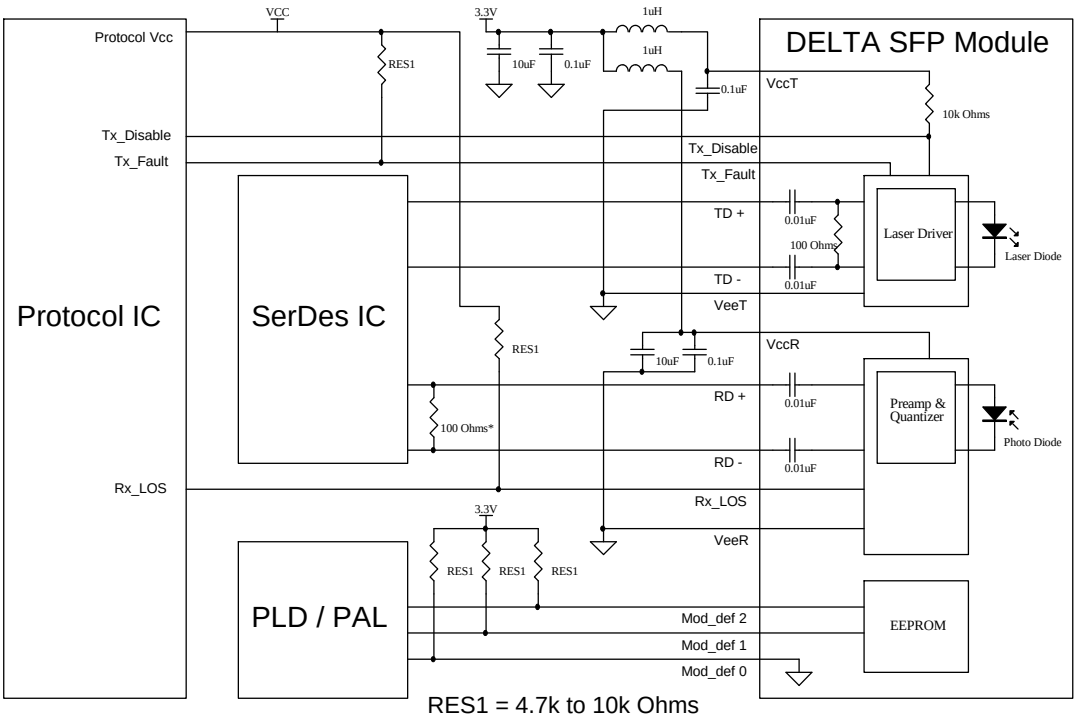


Figure 2.Mask of the eye diagram for the optical transmit signal (Ether mask IEEE Std.) 802.3

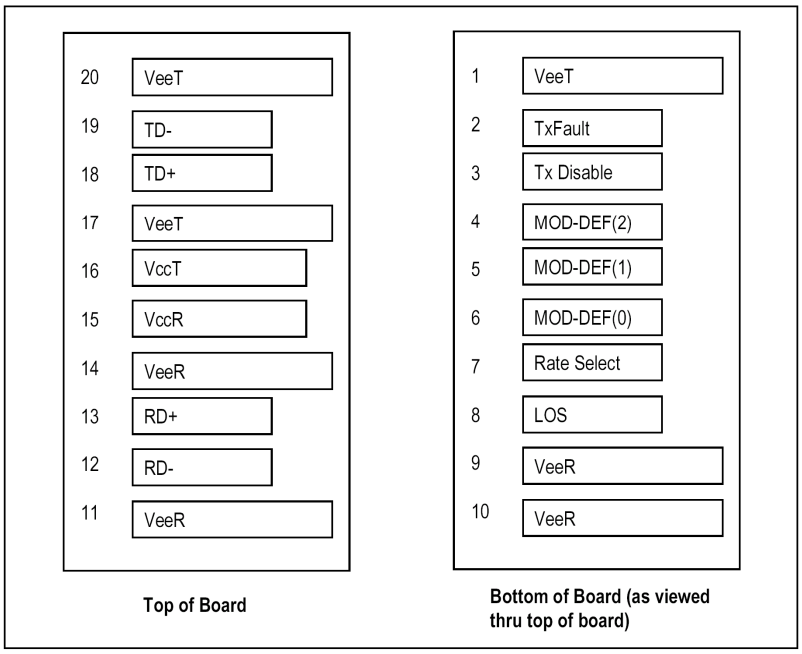
Recommend Circuit Schematic



RES1 = 4.7k to 10k Ohms

* Depands on SerDes IC used

SFP Transceiver Electrical Pad Layout



Pin Function Definitions

Pin Num.	Name	Function	Plug Seq.	Notes
1	VeeT	Transmitter Ground	1	
2	TX Fault	Transmitter Fault Indication	3	Note 1
3	TX Disable	Transmitter Disable	3	Note 2,Module disables on high or open
4	MOD-DEF2	Module Definition 2	3	Note 3, 2 wire serial ID interface
5	MOD-DEF1	Module Definition 1	3	Note 3, 2 wire serial ID interface
6	MOD-DEF0	Module Definition 0	3	Note 3, Grounded in Module
7	Rate Select	Not Connect	3	Function not available
8	LOS	Loss of Signal	3	Note 4
9	VeeR	Receiver Ground	1	Note 5
10	VeeR	Receiver Ground	1	Note 5
11	VeeR	Receiver Ground	1	Note 5
12	RD-	Inv. Received Data Out	3	Note 6
13	RD+	Received Data Out	3	Note 7
14	VeeR	Receiver Ground	1	Note 5
15	VccR	Receiver Power	2	3.3 ± 5%, Note 7
16	VccT	Transmitter Power	2	3.3 ± 5%, Note 7
17	VeeT	Transmitter Ground	1	Note 5
18	TD+	Transmit Data In	3	Note 8
19	TD-	Inv. Transmit Data In	3	Note 8
20	VeeT	Transmitter Ground	1	Note 5

Plug Seq.: Pin engagement sequence during hot plugging.

Notes:

1) TX Fault is an open collector/drain output, which should be pulled up with a 4.7K – 10KΩ resistor on the host board. Pull up voltage between 2.0V and VccT, R+0.3V. When high, output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.
2) TX disable is an input that is used to shut down the transmitter optical output. It is pulled up within the module with a 4.7 – 10 K Ω resistor. Its states are:
   Low (0 – 0.8V): Transmitter on
   (>0.8, < 2.0V): Undefined
   High (2.0 – 3.465V): Transmitter Disabled
   Open: Transmitter Disabled
3) Mod-Def 0,1,2. These are the module definition pins. They should be pulled up with a 4.7K – 10KΩresistor on the host board. The pull-up voltage shall be VccT or VccR (see Section IV for further details). Mod-Def 0 is grounded by the module to indicate that the module is present Mod-Def 1 is the clock line of two wire serial interface for serial ID Mod-Def 2 is the data line of two wire serial interface for serial ID
4) LOS (Loss of Signal) is an open collector/drain output, which should be pulled up with a 4.7K – 10KΩ resistor. Pull up voltage between 2.0V and VccT, R+0.3V. When high, this output indicates the received optical power is below the worst-case receiver sensitivity (as defined by the standard in use). Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.
5) VeeR and VeeT may be internally connected within the SFP module.
6) RD-/+: These are the differential receiver outputs. They are AC coupled 100Ω differential lines which should be terminated with 100Ω (differential) at the user SERDES. The AC coupling is done inside the module and is thus not required on the host board. The voltage swing on these lines will be between 370 and 2000 mV differential (185 – 1000 mV single ended) when properly terminated.
7) VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V ±5% at the SFP connector pin. Recommended host board power supply filtering is shown below. Inductors with DC resistance of less than 1 ohm should be used in order to maintain the required voltage at the SFP input pin with 3.3V supply voltage. When the recommended supply-filtering network is used, hot plugging of the SFP transceiver module will result in an inrush current of no more than 30mA greater than the steady state value. VccR and VccT may be internally connected within the SFP transceiver module.
8) TD-/+: These are the differential transmitter inputs. They are AC-coupled, differential lines with 100Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board. The inputs will accept differential swings of 500 – 2400 mV (250 – 1200 mV single-ended), though it is recommended that values between 500 and 1200 mV differential (250 – 600 mV single-ended) be used for best EMI performance.

SFP timing parameters for SFP management

Parameter	Symbol	Min.	Max.	Unit	Note
TX_DISABLE Assert time	t_off		100	µsec	1
TX_DISABLE Deassert time	t_on		100	msec	2
Time to initialize, including reset of TX_FAULT	t_init		300	msec	3
TX Fault Assert Time	t_fault		100	µsec	4
LOS Assert Time	t_loss_on		100	µsec	6
LOS Deassert Time	t_loss_off		100	µsec	7
Serial ID Clock Rate	f_serial_clock		100	kHz	

Notes:

1) Time from rising edge of TX_DISABLE to when the optical output falls below 10% of nominal.
2) Time from falling edge of TX_DISABLE to when the modulated optical output rises above 90% of nominal.
3) From power on or negation of TX_Fault using TX Disable.
4) Time from fault to TX fault on.
5) Time TX Disable must be held high to reset TX_Fault.
6) Time from LOS state to Rx LOS assert.
7) Time from non-LOS state to Rx LOS deassert.

Package Outline Drawing

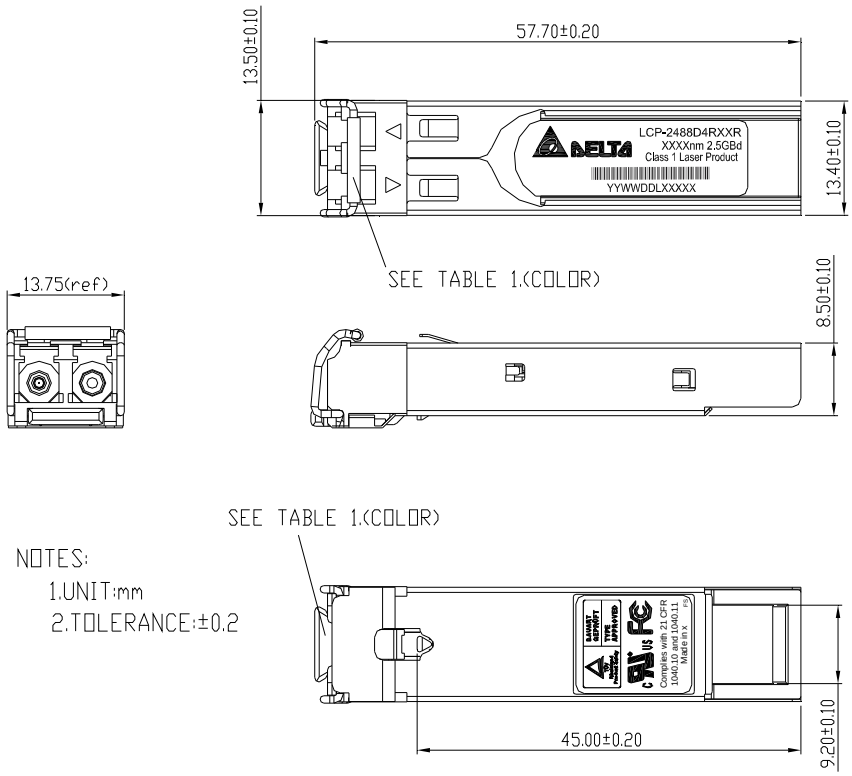
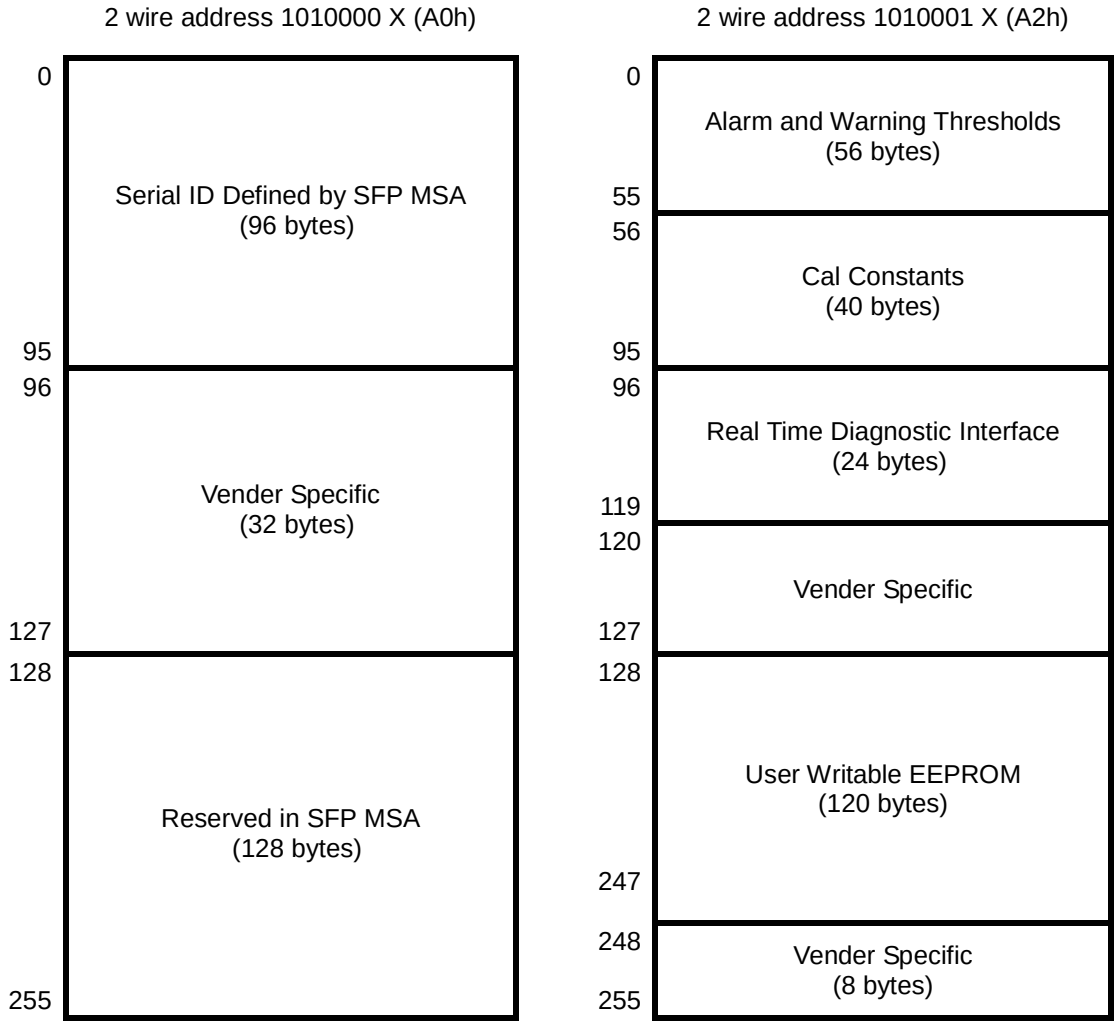


Table 1

Wavelength (nm)	Color
1470	Gary
1490	Violet
1510	Blue
1530	Green
1550	Yellow
1570	Orange
1590	Red
1610	Brown

Enhanced Digital Diagnostic Interface

The memory map in the following describes an extension to the memory map defined in SFP MSA. The enhanced interface uses the two wire serial bus address 1010001X(A2h) to provide diagnostic information about the module's present operating conditions.



Digital Diagnostic Memory Map Specific Data Field Descriptions

EEPROM Serial ID Memory Contents (2-Wire Address A0h)

Address	Hex	ASCII	Address	Hex	ASCII	Address	Hex	ASCII
00	03		43	PN		86	DC	
01	04		44	PN		87	DC	
02	07		45	PN		88	DC	
03	00		46	PN		89	DC	
04	0C		47	PN		90	DC	
05	44		48	PN		91	DC	
06	00		49	PN		92	58	
07	00		50	PN		93	F0	
08	00		51	PN		94	02	
09	00		52	PN		95	CS2	Note 6
10	00		53	PN		96	00	
11	03		54	PN		97	00	
12	19		55	PN		98	00	
13	00		56	30		99	00	
14	50		57	30		100	00	
15	FF		58	30		101	00	
16	00		59	0A		102	00	
17	00		60	CW	Note 2	103	00	
18	00		61	CW	Note 2	104	00	
19	00		62	01		105	00	
20	44	D	63	CS1	Note 3	106	00	
21	45	E	64	00		107	00	
22	4C	L	65	1A		108	00	
23	54	T	66	00		109	00	
24	41	A	67	00		110	00	
25	20		68	SN	Note4	111	00	
26	20		69	SN		112	00	
27	20		70	SN		113	00	
28	20		71	SN		114	00	
29	20		72	SN		115	00	
30	20		73	SN		116	00	
31	20		74	SN		117	00	
32	20		75	SN		118	00	
33	20		76	SN		119	00	
34	20		77	SN		120	00	
35	20		78	SN		121	00	
36	37		79	SN		122	00	
37	08		80	SN		123	00	
38	00		81	SN		124	00	
39	70		82	SN		125	00	
40	PN	Note1	83	SN		126	00	
41	PN		84	DC	Note 5	127	00	
42	PN		85	DC		128	00	Note 7

Notes:

1) Byte 40-55: Delta part number
2) Byte 60-61: The center wavelength of transmitter
3) Byte 63: Check sum of bytes 0-62.
4) Byte 68-83: Serial number.
5) Byte 84-91: Date code.
6) Byte 95: Check sum of bytes 64-94.
7) Byte 128 to 255 had been set hex 00.

Digital Diagnostic Monitoring Interface

Alarm and Warning Thresholds (2-Wire Address A2h)

Address	# Bytes	Name	Value (Dec.)	Unit	Note
00-01	2	Temp High Alarm	78	℃	
02-03	2	Temp Low Alarm	-13		
04-05	2	Temp High Warning	73		
06-07	2	Temp Low Warning	-8		
08-09	2	Voltage High Alarm	3.8	Volt	
10-11	2	Voltage Low Alarm	2.8		
12-13	2	Voltage High Warning	3.6		
14-15	2	Voltage Low Warning	3.0		
16-17	2	Bias High Alarm	I_{OP}*2+35	mA	1
18-19	2	Bias Low Alarm	I_{OP}-13		
20-21	2	Bias High Warning	I_{OP} *2+30		
22-23	2	Bias Low Warning	I_{OP} –8		
24-25	2	TX Power High Alarm	7	dBm	
26-27	2	TX Power Low Alarm	-2		
28-29	2	TX Power High Warning	6		
30-31	2	TX Power Low Warning	-1		
32-33	2	RX Power High Alarm	-8	dBm	
34-35	2	RX Power Low Alarm	-30		
36-37	2	RX Power High Warning	-9		
38-39	2	RX Power Low Warning	-29		
40-45	16	Reversed			
56-91	36	External Calibration Constants			
92-94	3	Reversed			
95	1	Checksum			2
96-97	2	Real Time Temperature			
98-99	2	Real Time Supply Voltage			
100-101	2	Real Time Tx Bias Current			
102-103	2	Real Time Tx Optical Power			
104-105	2	Real Time Rx Received Power			
106-109	4	Reserved			
110	1	Optional Status/ Control Bits			
111	1	Reserved			
112-119	8	Optional Set of Alarm and Warning			

Notes:

1) I_{OP}: Operating current at room temperature. The min. setting current is 0 mA.

2) Byte 95 contains the low order 8bits of sum of bytes 0-94.

State/ Control Bits

Byte	Bit	Name	Description
110	7	Tx Disable State	Digital state of the Tx disable input pin
110	6	Soft Tx Disable	Read/ Write bit that allow software disable of laser
110	5	Reserved	
110	4	Rate Select tate	NA
110	3	Soft Rate Select	NA
110	2	Tx Fault	Digital state of the Tx fault output pin
110	1	LOS	Digital state of the LOS output pin.
110	0	Data_Ready_Bar	NA

Optional Set of Alarm and Warning

Byte	Bit	Name	Description
112	7	Temp High Alarm	Set when internal temperature exceeds high alarm level
112	6	Temp Low Alarm	Set when internal temperature is below low alarm level
112	5	Vcc High Alarm	Set when internal supply voltage exceeds high alarm level
112	4	Vcc Low Alarm	Set when internal supply voltage is below low alarm level
112	3	Tx Bias High Alarm	Set when Tx Bias current exceeds high alarm level
112	2	Tx Bias Low Alarm	Set when Tx Bias current is below low alarm level
112	1	Tx Power High Alarm	Set when Tx output power exceeds high alarm level
112	0	Tx Power Low Alarm	Set when Tx output power is below low alarm level
113	7	Rx Power High Alarm	Set when received power exceeds high alarm level
113	6	Rx Power Low Alarm	Set when received power is below low alarm level
113	5-0	Reserved	
116	7	Temp High Warning	Set when internal temperature exceeds high warning level
116	6	Temp Low Warning	Set when internal temperature is below low warning level
116	5	Vcc High Warning	Set when internal supply voltage exceeds high warning level
116	4	Vcc Low Warning	Set when internal supply voltage is below low warning level
116	3	Tx Bias High Warning	Set when Tx Bias current exceeds high warning level
116	2	Tx Bias Low Warning	Set when Tx Bias current is below low warning level
116	1	Tx Power High Warning	Set when Tx output power exceeds high warning level
116	0	Tx Power Low Warning	Set when Tx output power is below low warning level
117	7	Rx Power High Warning	Set when received power exceeds high warning level
117	6	Rx Power Low Warning	Set when received power is below low warning level
117	5-0	Reserved	

Digital Diagnostic Monitor Accuracy

Parameter	Typical Value	Note
Transceiver Temperature	± 3℃	1
Power Supply Voltage	± 3%	2
TX Bias Current	± 10%	
TX Optical Power	± 3dB	3
RX Optical Power	± 3dB	4

Notes:

1) Temperature is measured internal to the transceiver.

2) Voltage is measured internal to the transceiver.

Regulatory Compliance

Test Item	Reference	Note
(#1) Electromagnetic Interference EMC	FCC Class B EN 55022 Class B CISPR 22	
(#2) Immunity： Radio Frequency Electromagnetic Field	EN 61000-4-3 IEC 1000-4-3	
(#3) Immunity： Electrostatic Discharge to the Duplex SC Receptacle	EN 61000-4-2 IEC 1000-4-2 IEC 801.2	
(#4) Electrostatic Discharge to the Electrical Pins	MIL-STD-883C Method 3015.4 EIAJ#1988.3.2B Version 2, Machine model	

Ordering information

LCP-2488D4 X_1 X_2 X_3R			
X_1:	**Link Budget** **R**: 28dB	**X_2X_3:**	**Wavelength**
			47: Single-mode 1470nm
			49: Single-mode 1490nm
			51: Single-mode 1510nm
			53: Single-mode 1530nm
			55: Single-mode 1550nm
			57: Single-mode 1570nm
			59: Single-mode 1590nm
			61: Single-mode 1610nm

Appendix A. Document Revision

Version No.	Date	Description
S0	2009-11-03	First released
S1	2009-12-02	Modify the optical power of Tx and sensitivity
S2	2010-05-03	1. Modify the receiver assert value 2. Modify the TX_DISABLE Assert time 3. Modify the TX_DISABLE Deassert time
S3	2010-05-18	1. Modify the receiver overload value 2. Add the color information on the mechanical drawing 3. Modify the value of alarm and warning
S4	2010-09-14	Correct the typo of ordering information.